Guest Editorial

Tissue engineering: Propagating the wave of change

Tissue engineering was defined almost 20 years ago by Langer and Vacanti in 1993 as an interdisciplinary field of research that applies both the principles of engineering and the processes and phenomena of the life sciences toward the development of biological substitutes that restore, maintain, or improve tissue function.[1] Since the inception of the concept, tissue engineering has propagated forward like a tidal wave, leaving a new understanding of stem cells and biomaterials in its wake. In contrast to the classic biomaterials approach taught in schools of medicine and dentistry, tissue engineering is based on the understanding of tissue formation and regeneration, and aims to induce new functional tissues, rather than just to implant new replacement or recycled, alloplastic or allogenic spare parts. This is meant not to undervalue the significant advancement made in the areas of facial transplantation[2] but to underscore the differences between the transplantation of allogenic organs and tissue engineered cell-based therapies.

In order to understand the complex role of the various components of tissue engineering, one should visualize an equilateral triangle where stem cells, resorbable scaffolds, and bioactive molecules such as growth factors continuously interact with each other [Figure 1]. The science of tissue engineering is built upon the understanding of the nature of the interactions between these three key components. Stem cells, for example, may be considered pluripotent, but can interact with growth factors in order to be stimulated to differentiate along certain cell lineages. Likewise when stem cells come into contact with the unique surfaces of certain scaffolds, they may be induced to differentiate along a variety of directions, forming bone or cartilage tissue for example. It is also important to be able to grow the bone in a three dimensional fashion. This can be achieved by using an appropriately designed scaffold, which enables the growing of custom-made tissues in correct predetermined sizes and shapes.

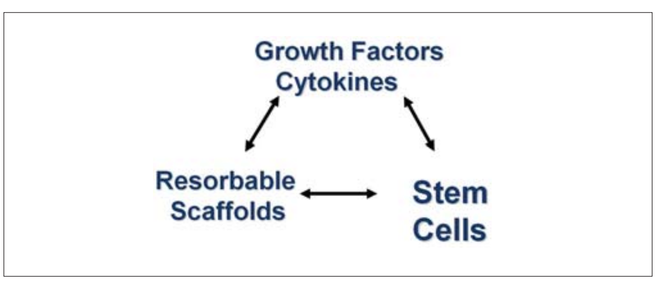

Figure 1: The equilateral triangle represents the multiple interactions of the three principal components of tissue engineering

In Finland, the first tissue engineered products were manufactured in late 2006. The cell source used for clinical treatments to replace large missing segments of craniomaxillofacial bone has been human adipose-derived stem cells (hASC). They have been incorporated to two different scaffolds depending on the application: Beta-tricalcium phosphate (β-TCP) and bioactive glass. In some patients, bone morphogenetic protein 2 (BMP-2) has also been used as a growth factor.[3]

Progress in cell-based tissue engineering has continued. Cartilage has been grown *ex-vivo* in order to manufacture a replacement tissue-engineered airway in Spain.[4] Tissue-engineered skin has been produced in Great Britain to treat severely injured burn patients.[5]

In order for these treatments to be realized as clinical reality, certain principles had to be followed by its pioneers. First and foremost researchers recognized the possibilities. Langer and Vacanti described and embraced the opportunities offered by change. Researchers also learned to engage nontraditional lateral thinking and think "outside-the-box" in designing their innovations. Researchers have been successful in presenting convincing arguments describing their vision both to their funding agencies and to their regulatory agencies to enable the forward development of such progress. Oral and maxillofacial surgeons are exceedingly well represented among those who design and devise tissue engineered replacements for craniomaxillofacial bone and continue to play an important role in this area of research and clinical application or translational science. The challenge in these financially taxing times of global recession and austerity is to continue the forward propagation of the tide wave of tissue engineering at a meaningful pace and not dampen its progress, in order to ensure the continuation of further improvements in patient care.

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